R E P O R T R E S U M E S

ED 014 891 64 EM 004 052

AN EXAMINATION OF THE STRUCTURE AND EFFECTIVENESS OF SLIDE-TAPES PRODUCED BY RATIONAL ANALYSIS AND SELF-SEQUENCING TECHNIQUES.

BY- PAULSON, CASPER F., JR.
OREGON STATE SYSTEM OF HIGHER EDUCATION, MONMOUTH

REPORT NUMBER R-58 PUB DATE JUN 67
REPORT NUMBER BR-5-0952
GRANT OEG-7-27-0000-238
EDRS PRICE MF-$0.25 HC-$1.44 34P.

DESCRIPTORS- *INDEPENDENT STUDY, *TEACHER IMPROVEMENT, *VISUAL STIMULI, *TAPE RECORDINGS, *COGNITIVE PROCESSES

SO THAT TEACHERS MAY LEARN TO IDENTIFY AND CONSTRUCT BEHAVIORAL OBJECTIVES, 2 TECHNIQUES FOR DEVELOPING SLIDE-TAPES WERE COMPARED ON THE BASIS OF STRUCTURAL CHARACTERISTICS OF SLIDE-TAPES PRODUCED AND OF ACHIEVEMENT RESULTING FROM THEIR USE. THE TECHNIQUES WERE RATIONAL ANALYSIS (RA) AND SELF-SEQUENCING (SS). RATIONAL ANALYSIS OF COMPLEX TERMINAL BEHAVIORS DESIRED LED BACKWARD THROUGH A HIERARCHY OF SUBORDINATE AND PREREQUISITE KNOWLEDGE AND SKILLS SUCH THAT AN RA SLIDE-TAPE WAS DEVELOPED. SELF-SEQUENCING BY AN INTERVIEWING TECHNIQUE WAS FOUND TO BE IMPRACTICAL. A POST-TEST ONLY DESIGN WAS USED TO COMPARE TREATMENT EFFECTS OF THE RA TAPE, AND OF A TAPE OF REARRANGED ELEMENTS FROM THE RA TAPE THAT WAS INTENDED TO BE PROBABLE UNDER A SS TECHNIQUE. DIFFERENCES APPROACHED SIGNIFICANCE FAVORING THE SS MODE, BUT SUGGESTED VARIABILITY OF EFFECTS WITH VARIATIONS OF SEQUENCE RATHER THAN SUPERIORITY OF THE SS TECHNIQUE. (LH)

ED014891

A BR-5-0952
PA. 64

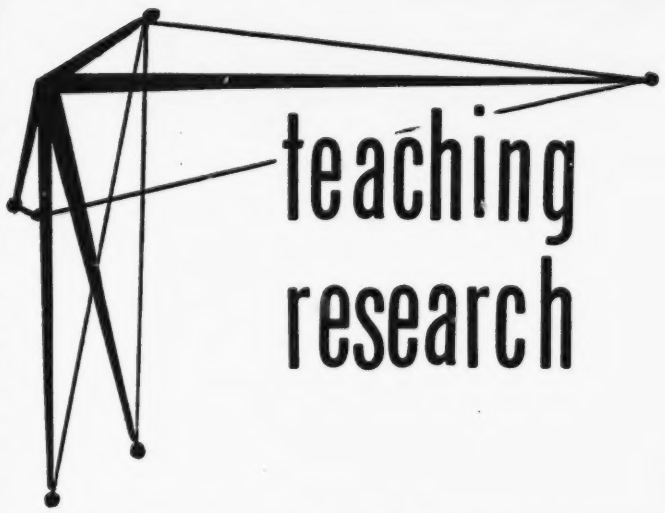
AN EXAMINATION OF THE STRUCTURE AND EFFECTIVENESS OF SLIDE-TAPES PRODUCED BY RATIONAL ANALYSIS AND SELF-SEQUENCING TECHNIQUES

Project No. 5-0952
Grant No. 7-27-0000-238

EM004052

Casper F. Paulson, Jr.

June, 1967



The Research Reported Herein was
Supported by a Grant from the
U. S. Department of Health, Education and Welfare
Office of Education

OREGON STATE SYSTEM OF HIGHER EDUCATIO

R-58

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

AN EXAMINATION OF THE STRUCTURE AND EFFECTIVENESS OF SLIDE-TAPES PRODUCED BY RATIONAL ANALYSIS AND SELF-SEQUENCING TECHNIQUES

Project No. 5-0952
Grant No. 7-27-0000-238

Casper F. Paulson, Jr.

June, 1967

The Research Reported Herein was
Supported by a Grant from the
U. S. Department of Health, Education and Welfare
Office of Education

TEACHING RESEARCH DIVISION
Oregon State System of Higher Education

Monmouth, Oregon

EM 004 052

CONTENTS

INTRODUCTION	Page 1
METHOD	Page 4
RESULTS	Page 8
DISCUSSION	Page 11
CONCLUSIONS	Page 14
SUMMARY	Page 15
REFERENCES	Page 16
APPENDICES	Page 17
ERIC REPORT RESUME	Page 30

Figure 1:	Comparison of sequence of presentation of elements in RA and SS slide tapes	6
Figure 2:	Rational analysis of the three-fold instructional objective	8
Figure 3:	Data obtained from sequencing subjects	9
Table I:	Analysis of Variance Summary: Objective Criterion Measures	10
Table II:	Analysis of Variance Summary: Reliability of the Mean of Ratings of Four Judges	11

A C K N O W L E D G E M E N T S

The investigator expresses his appreciation to

Dr. Armand Galfo, who produced the two slide-tape sequences, and otherwise rendered considerable assistance in many phases of this study,

The teachers and administration of the Dallas, Oregon, Public Schools, District #2, where the experimental phase of this study was conducted, and particularly to Mr. Gordon Kunke for his administrative cooperation,

Mrs. Catherine Rooth and Mr. Sidney Micek, who participated in the production of the slide-tapes,

Mr. Kevin Morse, who assisted in the development and scoring of criterion tests,

The numerous subjects in the developmental trials, who gave assistance generously and patiently.

Introduction

Artists and other specialists in the visual arts generally invest great time and effort in planning the production of a finished product. They take every possible precaution to insure against having to remake the product. For example, motion picture producers rely greatly on carefully prepared scripts and repeated rehearsals before committing their efforts to film. Artists frequently devote considerable time to preliminary sketches and color tests. Such efforts are directed primarily at achieving standards of quality with respect to the physical characteristics of the product. These specialists in the visual arts are less concerned with the behavioral effects of the product, i.e., their instructional effectiveness.

By contrast, the development of self-instructional materials usually follows directly from the statement of objectives. The rough draft of the instructional program is then reproduced in useable form and tried out on a group of learners to determine its effectiveness. If ineffective, the program is revised and tried out once again. The programer anticipates that his initial effort will be imperfect and relies on learner feedback obtained after the fact to develop his product.

It is becoming apparent that more effective and efficient methods are needed to apply the validation techniques of instructional programing to the production of other instructional materials such as motion pictures and slide-tapes. It is extremely costly to develop a motion picture by sequential testing and revision as self-instructional programs are. Still, it is extremely important that we employ such techniques to insure that single-presentation materials will have predictable learning effects. If this objective is to be achieved with these media, new procedures will have to be developed which are economically feasible in this context.

It has been the purpose of this study to explore questions regarding the relative merits of two techniques for developing slide-tape presentations which do have predictable learning effects. The techniques have been compared with respect to the feasibility of their implementation, the structural characteristics of the products they produced, and their effectiveness in terms of achievement produced by their use. The objective of both techniques was to teach skills in identifying and constructing behavioral objectives.

There are a number of existing procedures which programers of instructional materials may employ to insure that the first draft will more nearly attain the desired instructional objective. The techniques recommended by Gilbert, Barlow, and Homme and Glaser (See Stolurow, 1961, pp. 96-99) for example, employ a matrix method or a coding technique for classifying items while the program is under construction and later when it is being refined on the basis of learner feedback. At best, however, such procedures are check lists which permit the programer to make a careful accounting of the various kinds of items included in his program. In addition, there are specific techniques pertaining to individual frame writing and sequencing, such as "vanishing" and "cueing," which the programer typically employs in composing frames initially.

Two of the existing procedures which reasonably might serve as effective means for developing instructional films and slide-tapes guide the programer's efforts in the preparation of an initial set of materials for trial. One relies heavily on a rational analysis of the objectives and on principles of human learning. The other relies on direct feedback from learners obtained through interviews. The former will be identified hereafter as the "rational analysis" procedure, and the latter, which relies on learner feedback, will be called the "self-sequencing" procedure.

The rational analysis technique is modeled after Gagne (1962). According to Gagne, the tasks to be learned in the acquisition of a specific content objective may be identified by working backwards from the final task. The question is asked, "What would an individual have to know in order to perform this task successfully?" The answer to this question reveals subordinate knowledge which the individual must know in order to attain the ultimate objective. The subordinate knowledge is again subjected to the question, "What does one have to know in order to achieve this?" and still more subordinate knowledge is revealed in the answer.

By continuing this questioning procedure and working backwards from the ultimate objective, the hierarchy of subordinate knowledge is established. In the end, the final content objective is seen to rest on a framework of subordinate knowledge which becomes increasingly more simple and more general. Gagne also deals with "processes" as distinguished from knowledge. He does so by manipulating the programed "instructions" which determine the sequence of experiences, the format of each experience, the criteria for determining the learner's route at choice points, and so forth. Gagne has reported some attempts to study the effects of instructions designed to insure high recallability of subordinate knowledge and to guide the learner's thinking (Gagne, 1962, p. 361).

Next, flow charts are prepared for each of the subordinate facts and processes. A special notation was developed by Kersh (1963) for preparing flow charts of specific instructional materials which could be completed by another person independently without consultation with the person preparing the flow charts. With this notation it is possible to diagram for the programer the essential characteristics of the instructional program in sufficient detail for him to carry on independently. In practice, the subordinate facts are charted first. Each is handled separately, without particular regard for the programing requirements as spelled out by the process statements. The person doing the flow charting operates with the knowledge that he can alter the flow chart quite simply according to the subordinate process requirements after he has prepared the outlines for the subordinate objectives.

Mager (1961) has described the self-sequencing technique, in which the sequence of topics in an electronics course was determined by allowing trainees to ask a series of specific questions of a trained instructor, with the instructor maintaining a responsive rather than directive role. The sequence of topics that emerged was found to

be quite different than that which the instructor would have proposed. The sequence of questions moved "from simple whole to a more complex whole, or from general to specific," and was concerned "about function before structure." "Initial interest was in the concrete rather than the abstract, in things rather than in theory, in how rather than why."

Mager describes the technique thus: "(a) It is useful for determining the information available to the learner at the initiation of instruction. (b) It is useful to the instructional programer for determining an information sequence of maximum meaningfulness to the learner. (c) It is a useful technique for increasing the motivation of the learner."

It should be noted that in Mager's technique each learner determined his own objectives as he went along. The role of the instructor was completely responsive rather than directive. In a subsequent study, Mager and McCann (1962) presented subjects with 24 pages of specific instructional objectives. The learners, graduate engineers, were permitted to determine the sequence of the instruction. The content presented to each student varied because of variations in entry behavior and individual preferences. In no case did the sequence of topics selected by the subjects parallel the "logical order" that was exemplified in the formal course from which the instructional objectives were abstracted. This procedure resulted in a 65% time savings over the formal instruction, and the graduates of this instruction were deemed to be superior to the graduates of other formal instruction.

It is unlikely that this procedure will work equally well in all situations. One relevant variable seems to be sophistication in study skills (Campbell, 1964). Findings presented by Lewis and Pask (1965) indicate that even adult learners, in certain circumstances, may select for themselves sequences which are radically less efficient than those developed by experienced programmers.

It is important to note that the nature of the instructional experience to be developed for this study established certain constraints which required adaptation of the two sequencing techniques described above, the "rational analysis" technique and the "self-sequencing" technique. The instructional materials ultimately developed were to be a fixed-sequence continuous slide-tape presentation to be utilized by multiple learners at a single sitting. This requirement had the effect of limiting the scope of instructional objectives feasible of attainment, and of limiting the presentation to hopefully less than one hour in duration. The objectives were specific and fixed by the "instructor" rather than the learner. As employed experimentally, the "self-sequencing" mode actually consisted of the modal or typical response of previously tested subjects. The "self-sequencing" subjects in the experiment were not free to select the sequence of learning experiences.

The study sought to answer these questions:

1. Is there clear evidence that the use of the two techniques results in a product that is structurally different?

2. What is the nature of these differences?

3. Do the two techniques result in differential achievement of the objectives by comparable groups of learners?

Method

Developmental Activities

Rational Analysis (RA) Sequence

The slide-tape presentation was designed to teach three skills: (1)identifying behavioral objectives, (2) locating important parts of behavioral objectives, and (3) constructing behavioral objectives. While it is apparent that these objectives are not independent, and that the attainment of each contributes to the attainment of the next, it is conceivable that the third objective could be reached without mastery of all of the components of the first two objectives. Thus the specification of these three objectives required the inclusion of learning experiences that might not have been included if the third objective were the sole terminal objective.

Application of the rational analysis procedure described above to the attainment of these objectives resulted in the flow chart described in Results, Figure 2. It should be noted that hierarchical analysis does not necessarily produce a linear arrangement of components. In order to achieve such arrangements for a fixed-sequence presentation, it was necessary to augment the analysis with some rather arbitrary sequencing decisions. The decision to define "objective" before defining "behavior" was arbitrary. The order of presentation of the four elements considered necessary in a behavioral objective: Audience, Behavior, Conditions, Degree, was not dictated by analysis but by the opportunity to employ a mnemonic device (ABCD). However, such arbitrary sequencing decisions were the exception rather than the rule. For the most part, sequencing decisions were either dictated or suggested by the hierarchical analysis.

The analysis, augmented in the manner described above, served as design specification for the development of a 77-frame, 50-minute Rational Analysis (RA) slide-tape.

Self-Sequencing Mode

For reasons to be described later in this report it was decided to avoid the confounding effects of having subjects determine both the content and the sequence of their learning experiences. The content was held constant in both modes. The RA slide-tape sequence was divided into nine independent elements. These elements were so constituted that they could be conceived of as the response to a simple request

for information by a subject. Such statements were composed and printed on cards to be used by subjects in the next stage of the development of the self-sequencing mode. A slide projector was then modified (see Appendix C, D) and tape sequences identified so that any one of the sequences could be presented to a subject upon request. Ten subjects (not included in the subsequent experiment) were then exposed to the learning materials, each determining for himself the sequence in which the nine elements were presented. For the purpose of determining the ultimate order in which the nine elements would be presented to SS experimental subjects, the score for each component was determined by assigning the ordinal number in which a given component was requested by a given subject to that element. The sum of these ordinal numbers over the ten subjects constituted the score for that element. (See Results, Figure 3, and also Appendix A.) For example, Section 1 was requested first by three subjects, second by five, and third by two. Thus its "score" was 3 x 1 + 5 x 2 + 2 x 3, or 19. The sole purpose of the scoring was to determine the location of each of the elements in the ultimate self-sequencing mode.

The scores yielded by this procedure did not provide a basis for sequencing the SS slide-tape differently than the RA slide-tape. More extensive sequencing trials did not seem advisable, both because of the absence of noticeable trends, and because such a procedure loses economic feasibility for media producers rapidly with the increase in number of trials required. The investigator was faced with the problem of foregoing a comparison and simply describing the effects of the RA slide-tape, or arbitrarily modifying the sequence of elements in such a way as to provide a meaningful comparison. It was decided that, to the extent the scores did suggest a sequence, they would be utilized. Where scores were virtually identical, the sequence would be reversed. Thus sections I and II were reversed, and sections V, VI, and VII were re-ordered.

The comparison thus achieved was addressed to the question of whether chance differences in the employment of this sequencing procedure would actually produce differences in instructional effectiveness. In other words, since the RA slide-tape sequence was not inconsistent with data obtained from the self-sequencing trials, both the RA and the SS sequences could be conceptualized as possible outcomes of the SS procedure. The comparison could also be conceptualized as being between an RA sequence and one of many possible SS sequences. The sequence in which the nine sections were presented in the two treatments is depicted in Figure 1. The wording is that used on the cards supplied to self-sequencing trial subjects. The elements from the hierarchical analysis included in the respective sections are identified for reference. For example, I_1 refers to the first block under Identification in the flow chart presented in Figure 2.

Sequence of Sections in RA Slide-Tape	Sequence of Sections in SS Slide-Tape
I. Purposes of writing behavioral teaching objectives (Introduction).	II. "Behavior," for the purpose of writing behavioral objectives, is defined. $I_{1,2,3}$
II. "Behavior," for the purpose of writing behavioral objectives, is defined. $I_{1,2,3}$	I. Purposes of writing behavioral objectives (Introduction).
III. Identifying valid and useful indicators of desired student learning. I_4	III. Identifying valid and useful indicators of desired student learning. I_4
IV. Some keys to wording behavioral teaching objectives. $I_{5,6}$	VII. Analyzing behavioral objectives into their component parts. $A_{3,4,5}$
V. Examples of objectives written as behavioral and non-behavioral teaching objectives. $I_{7,8}$	VI. Characteristics and component parts of well-stated behavioral teaching objectives. $A_{1,2}$
VI. Characteristics and component parts of well-stated behavioral teaching objectives. $A_{1,2}$	V. Examples of objectives written as behavioral and non-behavioral teaching objectives. $I_{7,8}$
VII. Analyzing behavioral objectives into their component parts. $A_{3,4,5}$	IV. Some keys to wording behavioral teaching objectives. $I_{5,6}$
VIII. Rewording poorly stated objectives into well-stated behavioral teaching objectives. $C_{1,2}$	VIII. Rewording poorly stated objectives into well-stated behavioral teaching objectives. $C_{1,2}$
IX. An opportunity for you to try your hand at identifying, analyzing, and constructing behavioral teaching objectives. $C_{3,4}$	IX. An opportunity for you to take your hand at identifying, analyzing, and constructing behavioral teaching objectives. $C_{3,4}$

Figure 1. Comparison of sequence of presentation of elements in RA and SS slide-tapes.

Experimental Design

A post-test only comparison was considered to be the most appropriate design for the experiment. There was no a-priori basis for differentiating subjects with respect to differences in entry behavior or ability to achieve the criterion. The brevity of the treatment and the inability to eliminate the confounding effects of intervening experience, if the pretest were not administered immediately prior to the experiment, tended to increase the likelihood of a reactive effect of the pretest, and indicated that a pretest-post-test design was not appropriate.

Sixty volunteer subjects were obtained from the Dallas, Oregon, public schools to receive this treatment as a part of their in-service training. This group constituted a majority of the teachers in the school system, and thus the factor of selective bias was appreciably reduced. Systematic randomization procedures were employed to assign the available subjects to one of the two treatment groups. The groups were treated simultaneously in adjacent rooms. Because of the developmental procedures described above, the instructional sequences were identical in content and length, differing only in the sequence in which the separate elements of the instruction were presented. The slide-tape presentation was rendered automatic by use of one of the two tracks on the tape to send triggering pulses to the slide projector, eliminating the necessity for audible "beeps," and the possibility of human error in advancing the slides. Schematic diagrams of the modifications of equipment are described in Appendix C. Modifications are described verbally in Appendix D.

A criterion test (see Appendix B), consisting of sixty multiple choice items and two performance items in which subjects wrote behavioral objectives, was administered immediately following the experimental treatment. The test was designed to measure the ability of subjects to select from several alternatives:

1. the objective that is stated in behavioral or performance terms.

2. the objective that most accurately describes the desired performance.

3. the item that specifies an acceptable level of performance

4. the item that specifies the conditions under which the learning is to take place.

5. the item that best describes given examples of behavioral objectives, or selected portions thereof.

The performance section of the test was limited to the writing of two behavioral objectives because experience had indicated that for many such participants the expectation of more than that number was simply not reasonable. The items on the objective portion of the test were selected from a pool of approximately one hundred forty items on the basis of agreement by a panel of experts in writing

behavioral objectives as to the appropriate response to each of the items. It may well be that some difficulty and discrimination power was sacrificed in order to obtain validity for the answer key. Each of the two objectives written by each of the subjects in the experiment were evaluated simply for the presence or absence of each of four specified essential components without regard to the quality of expression of those components. Thus a subject either described a target population or he did not. Either his words adequately described a behavior or they did not. A phrase describing the conditions under which the performance was to be observed, or the degree to which the performance was demonstrated, received a score of one, without regard to how realistic or appropriate the statement was.

Results

The instructional objective for which the slide-tapes were developed was to teach skills of: (1) identifying behavioral objectives, (2) locating important parts of behavioral objectives, and (3) constructing behavioral objectives. Rational analysis of these objectives into their component parts yielded the arrangement of elements illustrated in Figure 2.

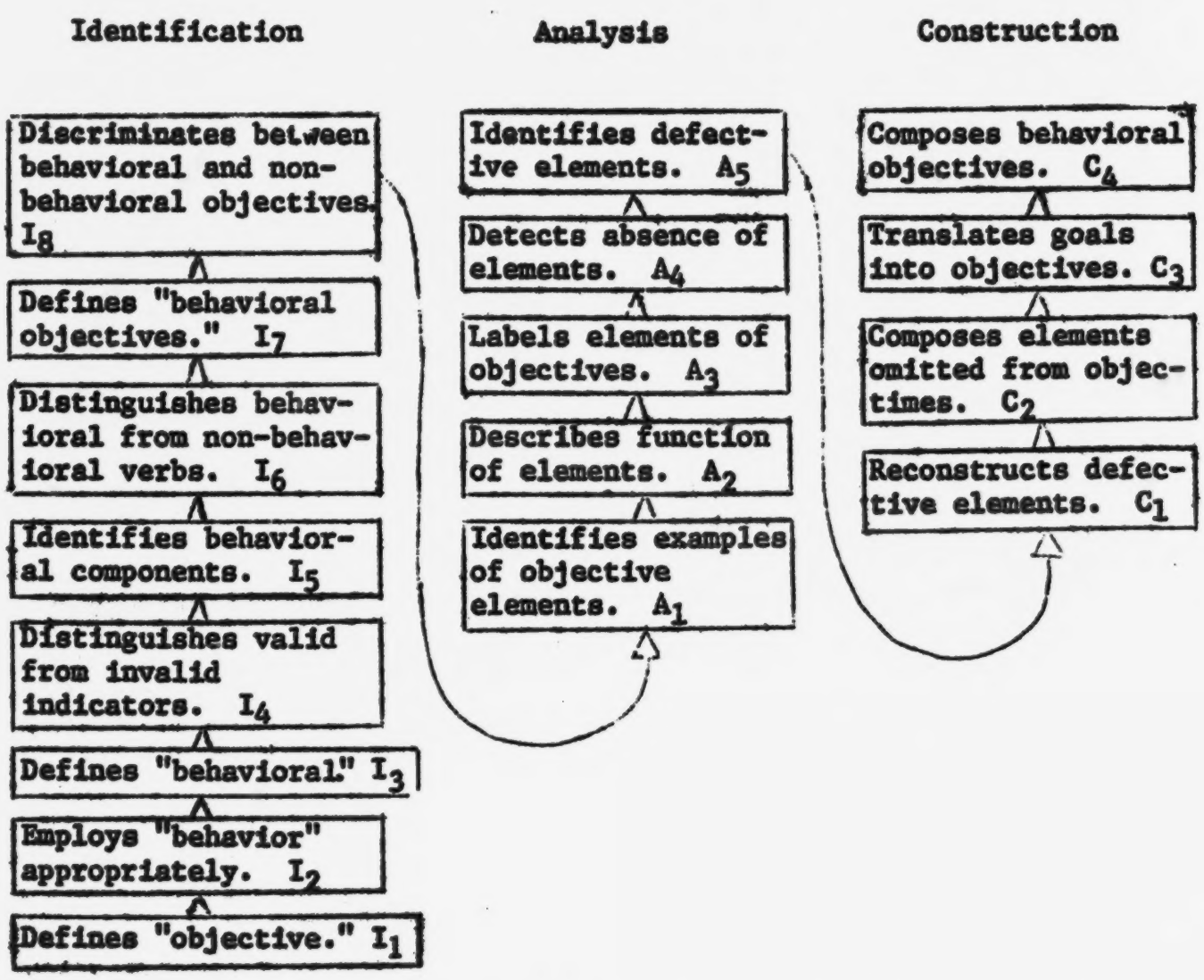

Identification
Analysis
Construction
Discriminates between behavioral and non-behavioral objectives. I8
Defines "behavioral objectives." I7
Distinguishes behavioral from non-behavioral verbs. I6
Identifies behavioral components. I5
Distinguishes valid from invalid indicators. I4
Defines "behavioral." I3
Employs "behavior" appropriately. I2
Defines "objective." I1
Identifies defective elements. A5
Detects absence of elements. A4
Labels elements of objectives. A3
Describes function of elements. A2
Identifies examples of objective elements. A1
Composes behavioral objectives. C4
Translates goals into objectives. C3
Composes elements omitted from objectives. C2
Reconstructs defective elements. C1

Figure 2. Rational analysis of the three-fold instructional objective.

From this analysis a 77-frame, 50 minute slide-tape was developed. In order to avoid confounding instructional time and content differences with sequencing effects, the same slides and tape were used in the SS mode, only presented in different sequence.

The RA slide-tape was separated into nine sections, rather than into the seventeen as might be suggested by the number of elements in the hierarchical analysis, because separation into smaller sections would have required considerably more transition and redundancy to maintain meaningfulness in the individual sections. Descriptors of the nine sections, and the order of their appearance in the respective slide-tapes, were depicted in Figure 1. Results of the self-sequencing trials are illustrated in Figure 3.

Section #	I	II	III	IV	V	VI	VII	VIII	IX
Subject									
1.	2	1	3	7	6	5	4	8	9
2.	2	1	8	3	6	4	5	7	9
3.	3	4	1	5	2	6	7	9	8
4.	1	2	3	4	8	5	6	7	9
5.	1	2	5	4	6	3	7	8	9
6.	3	2	1	7	4	6	5	8	9
7.	2	1	5	7	3	6	4	8	9
8.	1	2	6	7	5	3	4	8	9
9.	2	1	9	7	3	6	4	5	8
10.	2	1	8	6	5	4	3	7	9
Totals	19	17	48	57	48	48	49	75	88

Figure 3. Data obtained from sequencing subjects.

In answer to the question posed by the first objective of this study, there is no clear evidence that use of the two techniques resulted in a product that was structurally different. It can be noted that the scores accumulated by sections I and II were nearly identical, but substantially lower than the scores accumulated by sections III, IV, V, VI and VII. The scores for sections II-VII are seen to be quite similar and perhaps differ only by chance. Section VIII had a substantially higher score, and the score for section IX was higher yet. The results of the self-sequencing trials did not seem to indicate a sequence that was radically different from that determined by the rational technique. In order to maximize the difference between the self-sequencing and rational analysis slide-tapes, it was decided to organize the self-sequencing slide-tape in such a way as to maximize the difference in order of presentation between the two presentations of sections obtaining approximately the same score. As a result, the sequence of sections of the "self-sequencing" slide-tape was II, I, III, VII, VI, V, IV, VIII, IX.

Mean scores of the two treatment groups on the objective criterion test were quite similar. Mean score of the 29 SS subjects was 46.3, compared to a mean of 45.9 for the 27 RA subjects. Results of an analysis of variance are presented in Table I.

Table I

Analysis of Variance Summary: Objective Criterion Measures

Source	df	s.s.	m.s.	f
Treatments	1	5	5	.05
Within	54	5470	101	
Total	55	5475		

The performance portion of the test involved the writing of two behavioral objectives by each experimental subject. Each of the objectives were rated on a 0-4 scale on the basis of the presence or absence of each of 4 essential elements. The statements of objectives were rated by four judges. The reliability of the measures thus obtained was estimated by an analysis-variance procedure suggested by Winer (1962). The results are described in Table II.

Table II

Analysis of Variance Summary:
Reliability of the Mean of Ratings of Four Judges

Source	d.f.	s.s.	m.s.
Between Subjects	55	759.28	13.81
Within Subjects	168	251.75	1.50

$$r_4 = 1 - \frac{MS_{ws}}{M_{bs}} = .89$$

The performance score for each subject was the mean of the four judges' ratings. The mean for the SS group was 5.53, compared to 4.62 for the RA group. A two-tailed t-test was employed, for reasons to be discussed later. The result, t = 1.87, only approached significance at the .05 level.

Discussion

Before commencing the discussion of the treatments actually employed in this study, it is important to note that extensive efforts were made to employ a "self-sequencing" similar to that described by Mager (1961) in his earlier study. Initially, an interviewing technique was attempted, in which the "self-sequencing" subjects were informed of the terminal objectives, and directed to ask those questions of the behavioral objectives specialist which would, in the subject's opinion, lead to the attainment of those objectives. It soon became apparent that because the objectives were determined by the instructor, rather than by the subject, as had been the case in Mager's study, the burden of directing the course of the interview gravitated to the instructor. Subjects appeared to be motivated to cooperate with the investigator, but in a passive rather than an active way. The subjects' questions were of such a nature as to force the investigator to either respond with rather lengthy answers, or respond only partially. In either case, the instructor seemed to play a far more crucial role in determining the content and sequence than the subject did. Further, it soon became apparent that deriving the content and sequence for a mediated package of instruction from these lengthy interviews would require far more time than would usually be feasible for a slide-tape or motion picture.

An attempt was made to catalog questions asked by these subjects and answers to those questions. It was hoped that, on the basis of the frequency of requests for items of information, and the sequential pattern of such requests, sufficient information could be obtained to design an efficient "self-sequenced" slide-tape not too different in length from the rational analysis slide-tape. Unfortunately, the "catalog" seemed to extend rather than limit the range of questions asked by subjects. It seemed to the investigator that in a situation

where the objectives are convergent rather than divergent, and established by the instructor rather than by the student, and where efficiency in terms of instructional time and material costs is an issue, this open-ended "self-sequencing" approach is <u>not</u> feasible. Possibly more skillful conduct of the interviews might have led to more desirable results, but the problem of replicability of the procedure remains. The same problem would obtain in the application of decision rules in organizing and simplifying the data obtained.

As mentioned earlier in this report, implementation of the original plan for the development of the self-sequencing slide-tape would have resulted in confounding sequencing effects with instructional time and instructional content influences. Whereas this would have been inadvisable in a theoretical study, it would have been tolerable where the chief experimental concern was the comparison of two different procedures for attaining the same instructional objectives. However, the practical value of such a comparison disappears when one of the procedures appears not to be feasible. Restricting the instructional content to the materials available in the rational analysis slide-tape served to make the treatments identical in every respect except the sequence of presentation. It also radically simplified the task of collecting sequencing data.

The presumed beneficial effects of the utilization of the rational analysis feature include, in addition to optimal sequencing, a systematic methodology for including all necessary content and experiences, and excluding those that are unnecessary. As a result of the procedures utilized in the development of the two slide-tapes, the latter characteristics apply equally to both. If the use of such procedures should have pronounced effects on instructional effectiveness, their use may minimize or mask differences that would appear in their absence.

Results of the self-sequencing trials do not yield unambiguous sequencing information. A general trend can be noted of a sequence similar to that developed by rational analysis. The first two sections accumulated approximately equal scores, substantially lower than the other sections, and the scores of sections VIII and IX were substantially higher. Scores of the five middle sections, however, appeared to differ only by chance, if at all. This may have been due to the nature of the descriptors used. Other descriptors or procedures for subjects to call for instructional elements might have yielded less equivocal results.

The general agreement of the results of the self-sequencing trials with the rational analysis sequence may have been due to the fact that sequencing subjects were teachers, and may have acquired from experience or training a tendency to organize materials in a "rational" order.

The similarity of means of the two treatments, and the extremely low F-ratio are worthy of note. While one does not "prove the null," this finding seems to indicate that, for the kind of learning measured by this type of test, the chance variations in sequence likely to occur in utilizing the self-sequencing technique are not of crucial importance.

However, certain other factors may have contributed to the similarity noted in the treatment effects. The procedure employed in achieving a valid test key by consensus of individuals experienced in writing behavioral objectives may have adversely affected the discrimination power of the test items.

It may also be that each element of the instruction was sufficiently related to the experience of each subject that it could be comprehended meaningfully and retained, regardless of its ordinal position in the instructional presentation.

Also, as mentioned above, the possible effect of determining the content and learning activities by the rational analysis procedure, common to both treatment groups, may have served to make the learning effects more similar than had some other procedure been employed. Consequently, it may be hazardous to generalize the sequencing findings to situations where rational analysis procedures have not been employed.

Results of the performance test are marginal, approaching significance, and present some difficulty in interpretation. Since the sequencing of the "self-sequenced" slide-tape was to some extent arbitrary, and thus not readily replicated, it would seem that a one-tailed test would be appropriate wherein the null hypothesis would be that the mean of criterion scores for the RA slide-tape would not be significantly higher than that of the SS slide-tape. Viewed in this way, the null hypothesis would not even approach rejection, since the treatment differences favored the SS treatment and were thus in the opposite direction from the area of rejection. However, if the two treatments are viewed as two equally probable instructional sequences that might have been derived from the self-sequencing procedure, a directional hypothesis would not be appropriate and a two-tailed test would be indicated. Since such findings, if observed, would be of interest, this was the test employed.

Although the differences do not quite reach significance, they suggest areas for further research. It is possible that a relatively disordered sequence stimulates the student to a more complex intellectual activity and thus actually facilitates the learning of more complex skills. The findings may also tend to make one suspect the validity of objective instruments in predicting complex performance.

Conclusions

This study has sought to answer these questions:

1. Is there clear evidence that the use of rational analysis and self-sequencing techniques result in a product that is structurally different?

2. What is the nature of these differences?

3. Do the two techniques result in differential achievement of the objectives by comparable groups of learners?

With respect to the earlier and relatively unstructured attempts to allow subjects to determine both the content and sequence of instruction, it appeared that the product that would result from such a technique would be radically different from that developed by the rational analysis technique, particularly with respect to time and content. Attempts to allow subjects to determine both the content and sequence of instruction indicated that the instructional materials developed by such procedures would be extravagent with respect to instructional time and materials required. Furthermore, it appeared that those developers employing such techniques would still be required to employ considerable intuition in interpreting the data thus obtained, because the interviews conducted did not yield clear and unequivocal prescriptions for either the content and/or sequence of the instructional material. Thus, for situations where objectives are pre-determined and convergent, and where constraints on instructional time and amount of content exist, the relatively unstructured self-sequencing approach seems to be <u>not</u> generally feasible or appropriate.

With respect to the comparison performed in the experiment, wherein instructional time and content were held constant and only sequence was permitted to vary, there was no clear evidence that the two techniques resulted in structural differences. Results of an objective-type test administered to the treatment groups indicated quite similar achievement. Apparently, chance variations of sequence that might result from employing the "self-sequencing" technique have negligible effects on the type of learning measured by such tests.

With respect to actual performance by subjects in writing behavioral objectives, a difference favoring the self-sequencing mode approached, but did not reach, significance at the 5% level of confidence. The findings suggest the variability of the effects of the self-sequencing technique, rather than the superiority of the technique, since both sequences in actuality appear to be equally probable outcomes of application of the self-sequencing technique.

Results of this study do not warrant a recommendation that developers of instructional materials employ the self-sequencing techniques described here. The results do suggest, however, that sequencing variations may introduce variability with respect to certain types of performance criterion. This would indicate that further attempts should be made to develop empirical procedures for determining the optimal sequence for attainment of instructional objectives.

It would also seem desirable to replicate this study on a non-teacher sample. Quite possibly, the similarity between the rationally determined sequence and the empirically determined sequence was due to the fact that the sequencing subjects, who were all teachers, had acquired, through experience or training, habits of rationally organizing materials for presentation to their students.

The differences approaching significance on the performance criterion suggest the need for a replication of this study with more adequate performance measures. Finally, it would seem highly desirable to evaluate separately the contributions of two functions of rational analysis, that of delimiting content, and that determining sequence.

Summary

In this study, two techniques for developing a slide-tape presentation, from which teachers may learn to identify and construct behavioral objectives, were examined and compared with respect to the structural characteristics, particularly sequencing, of the product each technique produced and the effectiveness of each in terms of achievement produced by their use. The two techniques examined have been designated the rational analysis (RA) technique, and the self-sequencing (SS) technique.

The content and sequence of material in the slide-tape RA was dictated by a procedure involving analysis of the learning task by the experimenter. Working backward from the complex terminal behaviors desired, subordinate and prerequisite knowledge and skills were arranged hierarchically. This analysis served as design specification for the development of a 77-frame, 50-minute slide-tape.

An interviewing technique which would allow subjects to determine for themselves the content and sequence of instruction needed to achieve the terminal behaviors was attempted but found to be not feasible. Slide-tape RA was divided into nine sections and subjects were provided with descriptors of each section printed on cards, which they used to request each section in the order desired. Since the results of this procedure did not dictate a sequence different from that of slide-tape RA, the sequence was arbitrarily rearranged in those areas where no clear sequence preference was indicated, in order to achieve a sequence of instruction that was maximally different, but equally probable with the use of self-sequencing procedures.

Treatment effects, as measured by an objective test, were quite similar for the two treatments. Differences in treatment effects, as measured by a performance test, approached significance favoring the self-sequenced mode. Since the sequence of elements in the rational analysis mode was not inconsistent with the sequence derived from the sequencing trials, the possible differences in performance suggest variability of performance effects with variations of sequence, rather than superiority of the self-sequencing technique.

REFERENCES

Campbell, Vincent N. Self-direction and programed instruction for five types of learning objectives. Psychology in the Schools, I, (October, 1964), 348-359.

Gagné, Robert M. The acquisition of knowledge. Psychological Review, 1962, 69, 355-365.

Kersh, Bert Y. Programming classroom instruction. Teaching Machines and Programmed Instruction: II Data and Directions. Robert Glaser, (ed.), Department of Audio-Visual Instruction, National Education Association, 1965.

Lewis, Brian N., and Gordon Pask. The theory and practice of adaptive teaching systems. Teaching Machines and Programmed Learning: II Data and Directions. Robert Glaser, (ed.), Department of Audio-Visual Instruction, National Education Association, 1965.

Mager, Robert F. On sequencing of instructional content. Psychological Reports, Vol. 9, 1961, 405-413.

Mager, Robert F., and J. McCann. Learner-controlled instruction. Palo Alto, California: Varian Associates, 1962.

Stolurow, L.M. Teaching by Machine: Cooperative Res. Monogr. No. 6, (OE-34010) Washington, D.C.: U.S. Government Printing Office, 1961.

Winer, B.J. Statistical Principles in Experimental Design. San Francisco: McGraw-Hill Book Co., 1962, p. 124-132.

Appendix A

Procedure Employed in Sequencing Trials

Sequencing Trails - Behavioral Objectives Slide-Tape.

Inform subjects that the purpose of this slide-tape is to teach them to identify, analyze, and construct behavioral objectives. The instructional material has been divided into sections. The kind of presentation that is to be found in each section has been printed on the cards which the subject has been given.

The purpose of this part of the experiment is to determine the sequence of information people would select if given their choice. After a brief introductory sequence, each subject will read the card representing the information desired next. That card will then be set aside and the appropriate section shown. The process will be repeated until the subject has seen all sections.

Upon hearing the subject's request, the investigator will record the ordinal number of the requested section in the sequence of sections selected by that subject, on table provided below. He will then set the tape and slides for the appropriate section and present the section to the subject.

Section #	I	II	III	IV	V	VI	VII	VIII	IX
Subject									
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									
Totals									

Appendix B

Objective Criterion Test

Indicate your answers on the answer sheet by placing an X within the proper space(s) provided.

Please do not mark your answer in this test booklet.

I.

1. One way in which a written behavioral objective for teaching may differ from a non-behavioral objective is that the behavioral objective always specifies:
   A. Teaching methods
   B. Teacher behavior
   C. Length of a teaching unit
   D. Criteria for measurement.

2. An "objective," as it has been defined for the purposes of writing behavioral objectives, denotes:
   A. A goal that a teacher intends students to accomplish
   B. A desired goal for students to accomplish
   C. A goal for teachers to accomplish in their teaching methods
   D. A goal teachers would like to accomplish with their students

3. Generally, the most valid indications of student behavior that are related to a behavioral objective are those which:
   A. Reflect the objective indirectly
   B. Foster democratic ideals
   C. Allow the student to express himself
   D. Are linked directly with the objective

4. The following verbs might be used in writing behavioral objectives concerning the testing of geography. Which verb would require the least clarification in a behavioral objective?
   A. Understand
   B. Draw
   C. Locate
   D. Identify

5. The following verbs might be used in writing a behavioral objective for teaching high school English. Which verb would require the least clarification of a behavioral objective?
   A. Write
   B. Appreciate
   C. Illustrate
   D. Summarize

6. In a behavioral objective, the audience is:
   A. All the students in a particular grade or level
   B. Some of the students in a particular grade or level
   C. A group of students who are expected to reach the criterion in the behavioral objective
   D. A group of students who behaved as the objective indicates

7. The "conditions" of a behavioral objective specify
   A. The setting in which the students' behavior is to occur
   B. The actions which the teacher will observe
   C. The actions of the leader
   D. Criteria for measuring the student behavior

8. The "behavioral" aspect of a behavioral objective specifies:
   A. Teacher behavior
   B. Pupil behavior
   C. Behavioral conditions
   D. Measurement of behavior

II.

From each of the following groups of objectives select the one objective which is most nearly stated in behavioral terms.

9. A. To teach the students how to build a 3 x 5 inch jewel box...
   B. The student will learn the principles of constructing small boxes...
   C. Each 10th grade shop student will build a 3 x 5 inch jewel box...
   D. To show 10th grade students the proper way to construct a 3 x 5 inch box...

10. A. To remember the names of the ten provinces of Canada in such a way as to...
    B. To learn and remember the names of the ten provinces of Canada...
    C. To name and label the ten provinces of Canada on a blank map showing only...
    D. To appreciate the importance of the ten provinces of Canada...

11. A. To learn the names of the different latitudes of...
    B. To write on an outline map the names of the different latitudes of...
    C. To know the names of the different latitudes of...
    D. To remember how to identify the different latitudes of...

12. A. To teach the fundamentals of diagraming electrical circuits...
    B. To learn the fundamentals of diagraming electrical circuits...
    C. To diagram an electric circuit with all the fundamentals...
    D. To know how to diagram an electrical circuit.

13. A. To define the terms decagon, geometry, and equilateral...
    B. To learn the terms decagon, geometry and equilateral...
    C. To know the concepts decagon, geometry and equilateral...
    D. To understand the terms decagon, geometry and equilateral...

14. A. To explore the identification of various types of vegetation...
    B. To name and describe in writing ten types of vegeation...
    C. To learn the names of ten different types of vegetation...
    D. To know the names of ten different types of vegetation...

15. A. To point out five essential points on a map...
    B. To learn about five essential points on a map...
    C. To know and understand five essential points on a map...
    D. To appreciate the value of knowing five essential points on a map...

III.

From each of the following groups of behavioral objectives select the one that most accurately describes the <u>desired behaviors</u>.

16. A. Locate ten major oceans, bays and straits on an outline map.
    B. Identify ten major oceans, bays and straits on an outline map.
    C. Write the names of ten major oceans, bays and straits on an outline map.
    D. Be able to recognize ten major oceans, bays and straits on an outline map.

17. A. To send a four-word message by Morse code with a blink light.
    B. To send a Morse code message.
    C. To send a message with a blink light.
    D. To send a message using a code.

18. A. Must be able to read Spanish writing.
    B. Must translate Spanish into English verbally.
    C. Must read a Spanish paragraph and translate orally into English.
    D. Must be able to tell the differences between languages.

19. A. Must write a Campbell style library paper of at least ten pages.
    B. Must show an ability to write a library paper.
    C. Must write a Campbell style library paper and finish it.
    D. Must be able to write a paper of ten pages or more.

20. A. Must give 4 examples of methods used to teach biology.
    B. Must write examples of 4 basic instructional techniques in biology.
    C. Must demonstrate an ability to teach biology 4 different ways.
    D. Must show 4 examples of how to teach biology.

21. A. Find the ten largest cities in Canada.
    B. Locate the position of each of the ten largest cities in Canada.
    C. Write a list containing the ten largest cities in Canada in order of size.
    D. Recognize the rank of each of the ten largest cities in Canada.

22. A. Write on an isothermal map with a red pencil accurately.
    B. Find the three spots on an isothermal map with heaviest rainfall.
    C. Mark with a red pencil the 3 areas on an isothermal map with heaviest rainfall.
    D. Locate and recognize areas of heavy rainfall on an isothermal map.

IV.

From each of the following groups of statements select the one which most clearly specifies an acceptable level of performance.

23. A. To write a topic sentence suitable for three given related sentences.
    B. To write a good topic sentence without error.
    C. To write accurately a topic sentence in 3 minutes.
    D. To write a sentence for any topic.

24. A. To obtain a score of 50% on a final test for the course.
    B. Get a score of 50 or more on a 100 item final.
    C. Score better than at least half the class on the final test in this course.
    D. Must be able to answer correctly at least 50% of the items on a 100 question true-false test.

25. A. Write the names of the Canadian provinces on an outline map.
    B. Write the ten provinces on an outline map provided in class.
    C. Write the names of at least 7 of the 10 Canadian provinces in a 5 minute period.
    D. In five minutes write the names of ten provinces on a Canadian map.

26. A. To underline verbs in sentences accurately.
    B. To locate and underline verbs in sentences correctly.
    C. To underline all verbs in 10 sentences in 15 minutes with 2 or fewer errors.
    D. To write all verbs from 10 sentences on a separate sheet of paper.

27. A. By labeling a given outline map of waterways correctly within ½ hour.
    B. By being able to look at an outline map and locate waterways correctly.
    C. By placing waterways on an outline map accurately.
    D. By labeling without error all the waterways on an outline map in 30 minutes.

28. A. Must compute accurately to 1 decimal place at least 20 of 30 given division problems.
    B. Must work out long division problems in such a way as to demonstrate ability.
    C. Must finish accurately an assignment calling for solution of long division.
    D. Must be able to work 20 long division problems in 30 minutes.

29. A. Must be able to keep time to a given record of music.
    B. Must clap hands in 4/4 rhythm through ten bars of "Ten Little Indians."
    C. Must correctly clap in 4/4 rhythm, 4 counts in each measure, to a recording of "Ten Little Indians."
    D. Must be able to demonstrate the ability to keep time to a given record.

V.

From each of the following groups of statements select those which describe a <u>condition</u> under which an objective is to be measured.

30. A. Must be able to identify cones, cylinders, and prisms.
    B. Given a set of geometric shapes
    C. Within a period of 30 minutes with less than 3 errors
    D. Students in a 10th grade Geometry class

31. A. Without the aid of references
    B. 33 correct out of a possible 50
    C. 9th grade geography students
    D. Select the proper location of major rivers.

32. A. Compute the area of a circle.
    B. Without the aid of a slide rule.
    C. Following the proper formulas.
    D. 9th grade algebra students.

33. A. Given a problem of the following class.
    B. Select the correct answer in 60% of the class.
    C. Be able to answer correctly
    D. The entire 12 grade calculus group

34. A. In a period of less than 1 hour
    B. Without the aid of a reference map
    C. Find the location of a major continent
    D. Correctly in 40% of all cases

35. A. By arranging parallel lines on a given map
    B. The student will identify and label
    C. Three of the basic map projections
    D. Will spell all three correctly in a period of 5 minutes

36. A. The student will solve an algebraic equation
    B. Given a linear equation with one unknown
    C. Within a period of 40 minutes
    D. And follow the correct procedures

VI.

Each of the following statements is a part of a behavioral objective. For each statement select the answer which best describes what the statement refers to in the objective.

37. ..within a period of 20 minutes...
    A. Audience
    B. Behavior
    C. Condition
    D. Degree

38. ..the first year college geography class...
    A. Audience
    B. Behavior
    C. Condition
    D. Degree

39. ..given a set of carpenters tools...
    A. Audience
    B. Behavior
    C. Condition
    D. Degree

40. ..without the use of references...
    A. Audience
    B. Behavior
    C. Condition
    D. Degree

41. ..all auto repair men in electrical circuiting will...
    A. Audience
    B. Behavior
    C. Condition
    D. Degree

42. ..locate and label...
    A. Audience
    B. Behavior
    C. Condition
    D. Degree

43. ..with a slide projector and slides...
    A. Audience
    B. Behavior
    C. Condition
    D. Degree

44. ..identify the areas containing salt, phosphorous and...
    A. Audience
    B. Behavior
    C. Condition
    D. Degree

VII.

The following behavioral objectives are followed by a list of the four basic requirements necessary for a well stated objective. Select that requirement which you feel is <u>least</u> adequately met, or has been omitted altogether.

45. The sixth grade social studies student, given a slate outline map, will write the names of continents on it.
    A. Audience
    B. Behavior
    C. Condition
    D. Degree

46. Given roughly circular shapes with various arrows indicating direction the student shall select without error in a 5 minute period all those whose arrows indicate a clockwise rotation.
    A. Audience
    B. Behavior
    C. Condition
    D. Degree

47. The ninth grade social studies student will locate and name at least 4 of the 5 climatic areas of Canada.
    A. Audience
    B. Behavior
    C. Condition
    D. Degree

48. By the end of two months they should be able to type 20 words per minute for a period of five minutes with less than three errors.
    A. Audience
    B. Behavior
    C. Condition
    D. Degree

49. On an outline map provided, ninth grade geography students will identify and label the major rivers of the U.S. and Canada.
    A. Audience
    B. Behavior
    C. Condition
    D. Degree

VIII.

In the most of the following statements of behavioral objectives one or more parts have been worded badly or left out completely. For each one select the part or parts you think are inadequate and mark the appropriate response(s).

50. The student should know the names of three mathematicians and contribution of each to geometry.

A. Audience
B. Behavior
C. Conditions
D. Degree
E. All of these
F. None of these

51. Each student will write a topic sentence suitable for three given related sentences.

A. Audience
B. Behavior
C. Conditions
D. Degree
E. All of these
F. None of these

52. The student will identify at least three key steps in the proof of "The square root of two is an irrational number."

A. Audience
B. Behavior
C. Conditions
D. Degree
E. All of these
F. None of these

53. Given a subject which is consistently classified under the same number, to tell from the card catalog where to look for books in that subject. (Give call number as far as it consistently occurs.)

A. Audience
B. Behavior
C. Conditions
D. Degree
E. All of these
F. None of these

54. Students show perception of tonal relationships within a scale (major or minor) by singing with syllables or numbers, a familiar song at a tempo established by the teacher.

A. Audience
B. Behavior
C. Conditions
D. Degree
E. All of these
F. None of these

55. Given twenty notes written on a staff on the board with the bass clef, the class must write down the names of these notes in one minute, as indicated by teacher's start and finish signals, based on teacher's stop watch.

A. Audience
B. Behavior
C. Conditions
D. Degree
E. All of these
F. None of these

56. Given the titles of five books, to locate the names of the authors in the card catalog and write down the authors and titles in acceptable bibliographical form.

A. Audience
B. Behavior
C. Conditions
D. Degree
E. All of these
F. None of these

57. Each student will give the root meaning of the terms "geometry," "quadrilateral," "decagon," "circumference," and "inscribed."

A. Audience
B. Behavior
C. Conditions
D. Degree
E. All of these
F. None of these

58. The student will identify all basic shapes (cylinder, cone, prism, cube, and sphere) used in familiar buildings and structures.

A. Audience
B. Behavior
C. Conditions
D. Degree
E. All of these
F. None of these

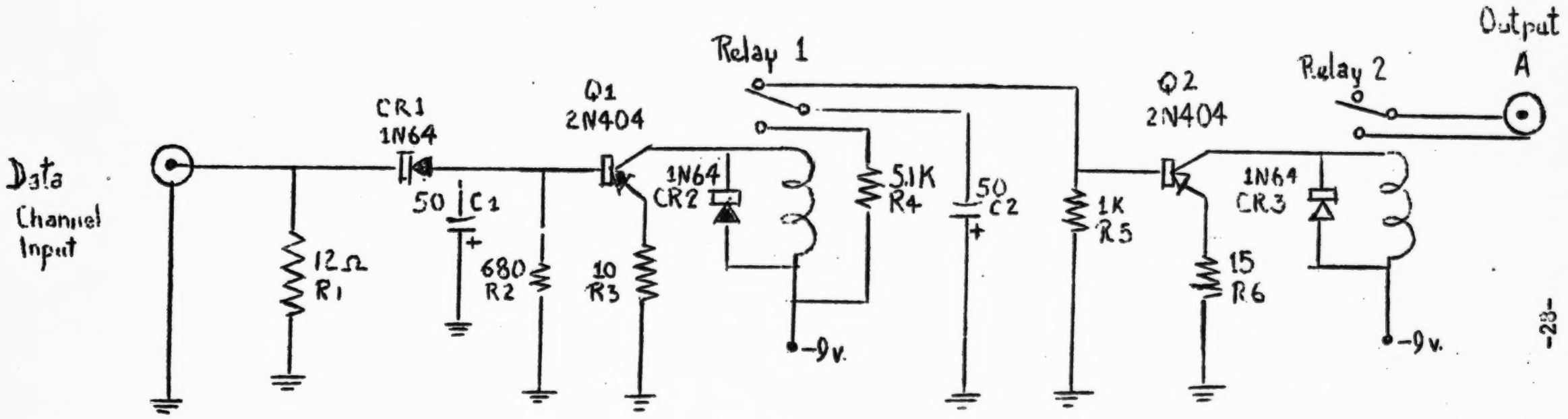
59. Spell correctly the following words after a 20 minute oral study period: cat, dog, bull, white, store. This will be a written exam which will last 5 minutes.

A. Audience
B. Behavior
C. Conditions
D. Degree
E. All of these
F. None of these

60. At the end of the two week library session, the pupils will locate, by the use of the card catalog, five books named by the instructor. A maximum time of five minutes will be allowed.

A. Audience
B. Behavior
C. Conditions
D. Degree
E. All of these
F. None of these

Appendix C



Relay 1 & 2 - P&B RS5D 6v.

Capacitors are in microfarads & 10 v.

Output A - Tied to advance circuitry of slide-projector

Slide Synchronizer

Appendix D

The slide synchronizer is installed in a Kodak Carousel projector, model 700. It is designed to advance slides with a 3.2 KC .8 second tone recorded on the number 4 track of the tape. The tape is played back on a stereo tape recorder. The tape recorder number 2 channel plays back the number 4 track of the tape. The number 2 channel output is fed into the slide synchronizer where the tone is rectified, the resulting negative voltage is applied to the base of Q1 causing it to conduct, and energizing relay 1. The closed contacts of relay 1 charge C2. When the tone stops, Q1 stops conducting and the relay is de-energized. The charge on C2 is then applied to the base of Q2 causing it to conduct, and energizing relay 2. The contacts of relay 2 close and cause the carousel advance circuitry to operate.

ERIC REPORT RESUME

Title: An Examination of the Structure and Effectiveness of Slide-Tapes Produced by Rational Analysis and Self-Sequencing Techniques

Personal Author: Casper F. Paulson, Jr.

Institution: Teaching Research Division, Oregon State System of Higher Education

Pub'l. Date: 6-30-67

Contract/Grant Number: Project No. 5-0952, Grant No. 7-27-0000-238

Pagination, etc: 30 Pages; also, 77-Frame Slide Tape

Abstract:

Two techniques for determining the content and sequence of slide-tape presentations were examined and compared, with respect to the structural characteristics and learning effects of each. Two slide-tapes were developed, in which the instructional objective was to enable teachers to identify and construct behavioral objectives.

The first technique employed a rational analysis of the learning task to determine the content and sequence of material to be presented in a slide-tape. This analysis served as design specification for the development of a 77-frame, 50-minute slide-tape. In the self-sequencing technique, content and sequence were to be determined empirically by trial subjects. An interviewing technique was attempted but found not feasible. Consequently, the rational analysis slide-tape was divided into nine sections, and sequencing trials were conducted wherein subjects were free to determine the order of presentation. Since the result did not dictate a different sequence, the elements were arbitrarily rearranged, where no clear sequence preference was indicated, to achieve a sequence that was maximally different, but equally probable.

Treatment effects, as measured by an objective test, were quite similar for the two treatments. Performance test differences approached significance favoring the self-sequencing mode. Since both sequences were possible outcomes of the self-sequencing technique, the result suggests that sequencing variations may produce variability in instructional outcomes, but the results do not indicate superiority of the self-sequencing technique over the rational analysis technique.